Bloating and floating don't have to spell death

Studying Barotrauma in Rockfishes

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This is what all bocaccio look like when brought to the surface. This fish is being measured, and the degree of barotrauma is recorded. Note the everted stomach hanging from the fish's mouth. This happens when the gas in the swim bladder overinflates, and the expansion of this organ causes the stomach to get pushed out of the mouth. The stomach will immediately retract as the gas within the swim bladder is recompressed when the fish is sent back down to the depth from which it was captured. (Photo: David J. Nelson)

Divers and fishers are well aware of the tell-tale signs of barotrauma (*e.g.*, everted stomachs, bulging eyes, skin blisters, prolapsed cloacas)—we should just be thankful this doesn't happen to us! Many fishes with closed, discrete swim bladders and highly vascularized tissues can experience "barotrauma," which results when fish are rapidly pulled to the surface and the gases within these tissues expand faster than can be released from the body. Unfortunately, the short and long-term effects of barotrauma on many species of fish are not well understood and pose a major problem in adequately managing fisheries.

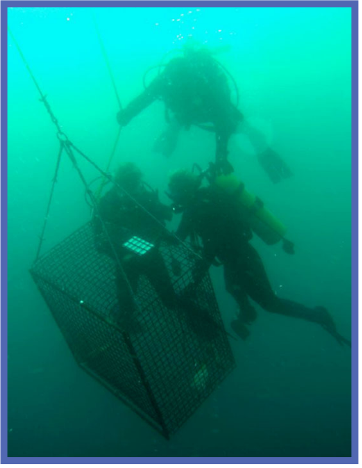
The California State University research vessel, the R/V Yellowfin. *All fishing and cage retrievals were conducted aboard this vessel, which was captained by Mr. Jim Cvitanovich, CSU Ocean Studies Institute Diving Safety Officer. (Photo: David J. Nelson)*

In southern California, rockfishes compose a major portion of the recreational and commercial fishery. Rockfishes of the family Scorpaenidae are physoclistic species, having a closed swim bladder used for buoyancy control. When these fish are brought to the surface by anglers, their swim bladders expand, causing positive buoyancy and a variety of decompression-related injuries including stomach eversion, corneal gas bubbles, air embolism, and swim bladder ruptures. Many of these fish are assumed dead upon capture. Unwanted fish are often tossed overboard and, as a result of positive buoyancy, ultimately succumb to thermal shock or predation by birds and marine mammals at the surface. Fishery managers have not implemented size limits for most species of rockfish because barotrauma-induced mortality was assumed to be so high. In recent years, concerns of declining stocks and the average size of fish caught have raised questions about the viability of the rockfish fishery in southern California and other locations along the eastern Pacific.

Dr. Chris Lowe carefully removes a bloated rockfish from CSULB Marine Biology undergraduate student Corey Mead's fishing line. (Photo: David J. Nelson)

A holding tank full of barotraumatized fish that have been carefully assessed and photographed and are waiting to be placed in a cage at their original depth of capture. Fish will be held 3–20 min in this tank, depending on when they were first caught and when the cage is dropped. (Photo: David J. Nelson)

During the summers of 2005 and 2006, graduate student, Erica Jarvis and Dr. Chris Lowe of California State University–Long Beach conducted experiments aboard the California State University R/V *Yellowfin* to investigate the effects of barotrauma on release survival of 17 species of rockfish. Experiments were designed to first characterize the degree of barotrauma across species and with increasing depth and secondly, to determine release survival following forced recompression. To test release survival, a team of CSULB students and volunteers conducted 42 fishing trips off the coast of Huntington Beach, CA, where over 250 individuals of 17 species of rockfish



A team of divers meeting the cage of fish at 60 ft. This prevents the fish from re-experiencing the effects of barotrauma and allows the divers to assess how many of the fish have survived and to describe their condition after 2 days. (Photo: Derek Smith)

were captured by hook-and-line at depths ranging from 50 to 90 m. Each fish was assessed for barotrauma injuries, tagged, and placed in cages that were lowered to the depth of their original capture. Two days later, cages were brought up to diver depth (20 m), where a team of divers met the cage, assessed the condition of each fish, and released all live individuals but one. Assessment of fish at depth allowed divers to determine recompression recovery and short-term survival without retraumatizing fish in a second decompression. A subsample of live fish and all dead fish were dissected to quantify internal signs of barotrauma.

One of the many vermilion rockfish found to survive after experiencing severe barotrauma. This fish had experienced "pop-eye" and everted stomach upon capture. Here is the fish 2 days after that experience. Fish are tagged with external Hallprint ID tags so they can easily be identified underwater. (Photo: Chris Lowe)

Because cage experiments occurred in water greater than 90 m deep and in areas with occasional low visibility and strong currents, the boat was not anchored and therefore fish assessment dives were managed using blue-water diving protocols. The cages were pulled and tethered to the boat and held at a depth of 20 m. A team of three divers, consisting of a safety diver, a data taker, and a fish "wrangler," were deployed from the R/V *Yellowfin* after the cage was secure at the appropriate depth. A supplemental "bailout" bottle and regulator was lowered to 5 m. The safety diver was responsible for attaching the end of a 22-m heavy safety line to the cage and for remaining just above the work divers on the safety line to keep watch and prevent work divers from losing contact with the cage.

The results revealed an overall survival rate of 68%; indicating that rockfish bycatch mortality can be reduced if fish are recompressed to depth after capture. In addition, the more quickly fish are returned to depth after capture, the higher the survival rate. Bocaccio (*Sebastes paucispinis*), a species of concern, showed the highest survival rate of all species investigated (80%), which included vermilion rockfish (*S. miniatus*), flag rockfish (*S. rubrivinctus*), and squarespot rockfish (*S. hopkinsi*), among others. Other factors accounted for in the field but that were not significant predictors of survival included depth, caged-fish density, and fish length. Upon examination by divers at depth, virtually none of the rockfish showed external signs of barotrauma, and none of the signs of barotrauma observed upon capture were significant predictors of short-term survival. Additional work conducted by Dr. Lowe and graduate students provides evidence of rockfish post-release survival at least two years following recompression. These results will be important in determining the necessary actions taken by fisheries managers to reduce rockfish bycatch mortality in the southern California recreational fishery.

Two flag rockfish survive two days post-recompression in cages after showing popped eyes, corneal gas bubbles, and everted stomachs upon capture. After two days, these fish no longer showed these signs of barotrauma. Fish are tagged with external Hallprint ID tags so they can easily be identified underwater. (Photo: Derek Smith)

Graduate students Erica Jarvis and Chris Mull releasing a fish held in the cage for two days after carefully assessing its condition. (Photo: Derek Smith)

Dr. Lowe's research lab continues to investigate other aspects of angling-induced barotrauma in rockfishes, including physiological stress responses and visual impairment. Funding for this research was provided by USC Sea Grant, Southern California Academy of Sciences, SCTC Marine Biology Education Foundation, and CSULB. Erica Jarvis is currently a research diver and biologist with the California Department of Fish and Game in Los Alamitos, California and Dr. Lowe is the chair of the CSU–Ocean Studies Consortium Diving Control Board.

Photographers:
Derek Smith is a volunteer research diver and the Diving Safety Officer from the Long Beach Aquarium of the Pacific. David J. Nelson is a staff photographer from CSULB Public Relations.